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Apertureless Scanning Near-Field Infrared Microscopy of Polymers

by

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Introduction

Scanning near-field microscopy provides optical resolution far beyond the diffraction limit of conventional microscopy. It has been used to characterize samples ranging from semiconductors to polymers to biological materials using electromagnetic (EM) radiation from ultraviolet to radio waves. The most common approach is to use the light emitted by a sub-wavelength aperture placed near the sample's surface as a light source and to detect the resulting EM radiation, scattered, transmitted or emitted by the sample. This aperture probe approach is usually provides ~$\lambda/20$ resolution in the visible part of the EM spectrum and at best $\lambda/10$ in the infrared (λ is wavelength of light). An alternative technique employs metallic, semiconductor or dielectric probes as a local scatterer of EM radiation in the vicinity of the sample surface (this method was proposed by Wessel in 1985, for original experimental implementations see References This approach has been used to detect local scattering as well as one- and two- photon fluorescence from under the probe.. Apertureless imaging usually provides resolution superior to the aperture probe approach, and the limitation of the probe transmission bandwidth is circumvented. The resolution is often exceeding $\lambda/100$ in the visible and $\lambda/300$ in the infrared. Radiation scattered by the sample is affected by the local optical properties of the sample and by the geometry of the probe-sample assembly. EM radiation at the surface of inhomogeneous sample varies according to the sample's properties. When scattered radiation propagates away from the sample, high spatial components decay, resulting in the well-known resolution limit of far-field microscopy

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13. ABSTRACT (*Maximum 200 words*)

Infrared near field microscopy using an apertureless probe technique has been accomplished to study the surfaces of a cast copolymer film. Two basic models for the predicted signal and the experimental data are presented. The first model includes plane wave light scattering by a conductive sphere and an infinitely wide absorptive layer placed on a semi-infinite conductor. This model shows infrared signal dependence on the layer absorption and predicts topographic coupling into the infrared signal. The experimental data also indicate that a significant component in the infrared contrast arises from the probe following the sample's topography, and a method to eliminate the influence of topography following is demonstrated. The images corrected by such a procedure show spatial resolution approximately $\lambda/100$. A more complex model based on a three dimensional finite difference time domain method was used to calculate scattering from an inhomogeneous surface.

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